

IN THE CLAIMS:

Please cancel claim 6 and 24 without prejudice to or disclaimer of the subject matter recited therein.

Please amend claims 1-5, 7-23, and 25-34, and add new claims 35-44 to read as follows. All claims now pending are provided below according to current U.S. Patent and Trademark Office practice.

1. (Currently amended) An image reading imaging optical system for imaging image information on a line sensor and reading the image information, ~~characterized by the system having~~ (i) an image optical element including a plurality of off-axial reflecting surfaces differing in the direction of incidence and the direction of emergence of a reference axis ray from one another and having curvatures, and (ii) an angle of field.

2. (Currently Amended) An image reading imaging optical system according to Claim 1, ~~characterized in that wherein~~ said imaging optical element has the function of changing the direction of emergence of the reference axis ray to a direction substantially perpendicular or opposite to the direction of incidence of the reference axis ray.

3. (Currently Amended) An image reading imaging optical system according to Claim 1 or 2, ~~characterized in that wherein said imaging optical element comprises a~~ the plurality of off-axial reflecting surfaces include ~~including~~ at least one set of

reflecting surfaces intersecting with each other, and ~~has~~ a stop is located between the off-axial reflecting surfaces intersecting with each other.

4. (Currently Amended) An image reading apparatus comprising:
having
an original supporting table on which an original is ~~placed~~; placed;
an imaging optical element for imaging image information on the surface of
the original on a line sensor; and
a line sensor for , ~~and for causing image information on the surface of the~~
~~original to be imaged on the line sensor by the imaging optical element, and reading the~~
~~image information by said line sensor,~~
~~characterized in that~~ wherein said imaging optical element has a plurality of
off-axial reflecting surfaces differing in the direction of incidence and the direction of
emergence of a reference axis ray from one another and having ~~curvatures~~ curvatures, and
wherein the apparatus has an angle of field.

5. (Currently Amended) An image reading apparatus according to
Claim 4, ~~characterized in that~~ wherein the bending direction of the reference axis ray on
each off-axial reflecting surface of said imaging optical element is in a cross section
perpendicular to the line direction of said line sensor.

6. (Cancelled)

7. (Currently Amended) An image reading apparatus according to Claim 5 6, ~~wherein characterized in that~~ the direction of the reference axis ray emerging from said imaging optical element is substantially orthogonal to the direction of the reference axis ray incident on said imaging optical element.

8. (Currently Amended) An image reading apparatus according to Claim 5, ~~characterized in that~~ wherein the direction of the reference axis ray emerging from said imaging optical element is substantially the same direction as the direction of the reference axis ray incident on said imaging optical element.

9. (Currently Amended) An image reading apparatus according to Claim 5 6, ~~characterized in that~~ wherein the direction of the reference axis ray incident on said imaging optical element and the direction of the reference axis ray emerging from said imaging optical element are substantially opposite directions.

10. (Currently Amended) An image reading apparatus according to Claim 4, ~~characterized in that~~ wherein said image information is not intermediately imaged in said imaging optical element, but is directly formed on said ~~the~~ line sensor.

11. (Currently Amended) An image reading apparatus according to Claim 10, ~~characterized in that~~ wherein said imaging optical element has a stop near substantially the center of the optical path between a ~~the~~ light incidence surface and a ~~the~~ light exit surface thereof.

12. (Currently Amended) An image reading apparatus according to Claim 11, ~~characterized in that said~~ wherein the stop is formed by an ~~the~~ effective surface of an off-axial reflecting surface located near substantially the center of the optical path between the light incidence surface and the light exit surface of said imaging optical element.

13. (Currently Amended) An image reading apparatus according to Claim 4, wherein ~~characterized in that~~ an internal medium constituting said imaging optical element is air.

14. (Currently Amended) An image reading apparatus according to Claim 4, ~~characterized in that~~ wherein an internal medium constituting said imaging optical element is optically transparent glass or plastic.

15. (Currently Amended) An image reading apparatus according to Claim 5, ~~characterized in that~~ wherein when an ~~the~~ off-axial reflecting surface for counter-clockwisely deflecting the reference axis ray is defined as a plus deflecting surface, and an ~~the~~ off-axial reflecting surface for clockwisely deflecting the reference axis ray is defined as a minus deflecting surface, said imaging optical element has at least one set of constructions in which the plus deflecting surface is continuous or at least one set of constructions in which the minus deflecting surface is continuous.

16. (Currently Amended) An image reading apparatus according to Claim 5, ~~characterized in that~~ wherein when an the off-axial reflecting surface for counter-clockwisely deflecting the reference axis ray is defined as a plus deflecting surface, and an the off-axial reflecting surface for clockwisely deflecting the reference axis ray is defined as a minus deflecting surface, said imaging optical element has at least one set of constructions in which the plus deflecting surface is continuous and at least one set of constructions in which the minus deflecting surface is continuous.

17. (Currently Amended) An image reading apparatus according to Claim 5, ~~characterized in that~~ wherein said imaging optical element is comprised of six off-axial reflecting surfaces, and when ~~the~~ an off-axial reflecting surface for counter-clockwisely deflecting the reference axis ray is defined as a plus deflecting surface, and an the off-axial reflecting surface for clockwisely deflecting the reference axis ray is defined as a minus deflecting surface, said imaging optical element has the same number of plus deflecting surfaces and minus deflecting surfaces, and the off-axial reflecting surface most adjacent to the exit side is disposed on the original side on the incidence reference axis relative to the off-axial reflecting surface most adjacent to the incidence side.

18. (Currently Amended) An image reading apparatus according to Claim 17, ~~characterized in that said~~ wherein the plus deflecting surfaces and ~~said~~ the minus deflecting surfaces are disposed so as to be opposite deflecting surfaces relative to a stop.

19. (Currently Amended) An image reading apparatus according to Claim 17, ~~characterized in that the~~ wherein an off-axial reflecting surface of said imaging optical element which is most adjacent to the incidence side is designed to have ~~the a~~ converging action.

20. (Currently Amended) An image reading apparatus according to Claim 17, ~~characterized in that~~ wherein at least one off-axial reflecting surface of said imaging optical element ~~has a characteristic of cutting~~ cuts infrared light.

21. (Currently Amended) An image reading apparatus according to Claim 17, ~~characterized in that~~ wherein said imaging optical element is disposed in a housing along the surface of the original in parallel to a reflecting mirror.

22. (Currently Amended) An image reading apparatus according to Claim 4, ~~characterized in that~~ wherein when an the effective beam width in a direction perpendicular to the line direction of the line sensor on the exit surface of said imaging optical element is defined as Φ_s , and an ~~the~~ effective beam width in the line direction of the line sensor is defined as Φ_m , ~~the condition that~~

$$\Phi_s < \Phi_m$$

~~is satisfied.~~

23. (Currently amended) An image reading apparatus having
comprising:
an original supporting table on which an original having image information
on a surface thereof is placed; placed;
an imaging optical element for causing the image information on the surface
of the original to be imaged on and a line sensor, the imaging optical element having a
plurality of off-axial reflecting surfaces differing in the directio of incidence and the
direction of emergence of a reference axis ray from one another and having curvatures;
a line sensor for reading the image information; and
~~for causing image information on the surface of the original to be imaged on~~
~~the line sensor by the imaging optical element, and reading the image information by said~~
~~line sensor, characterized by a reflecting mirror, mirror and an~~
wherein said reflecting mirror and said imaging optical element for
~~reflecting a~~ reflect the reference axis ray a plurality of times, and ~~in that~~ said imaging
optical element has the function of changing a the direction of emergence of the reference
axis ray to a direction substantially perpendicular or opposite to the direction of incidence
of the reference axis ray, and ray
wherein the apparatus has an angle of field.

24. (Canceled)

25. (Currently Amended) An image reading apparatus according to Claim 23 ~~Claim 24~~, characterized in that wherein the bending direction of the reference axis ray on each off-axial reflecting surface is in a cross section perpendicular to a ~~the~~ line direction of said line sensor.

26. (Currently Amended) An image reading apparatus according to Claim 23 ~~claim 24~~, characterized by further comprising at least two reflecting mirrors.

27. (Currently Amended) An image reading apparatus according to Claim 23 ~~Claim 24~~, characterized in that wherein said imaging optical element is disposed on the side opposite to the surface of ~~said~~ the original with respect to said reflecting mirror.

28. (Currently Amended) An image reading apparatus according to Claim 23 ~~Claim 24~~, characterized in that wherein said imaging optical element is disposed in a housing along the surface of the ~~said~~ original in parallel to said reflecting mirror.

29. (Currently Amended) An image reading apparatus comprising:
having
an original supporting table on which an original is placed; ~~placed;~~
an imaging optical element for imaging image information on the surface of
the original on a line sensor, and a line sensor, and for causing image information on the
surface of the original to be imaged on the line sensor, and reading the image information

~~by said line sensor, characterized in that wherein~~ said imaging optical element
~~including includes~~ a plurality of off-axial reflecting surfaces including at least one set of
reflecting surfaces intersecting with each other; ~~has~~ a stop between the off-axial
reflecting surfaces intersecting with each other; and
a line sensor for reading the image information.

30. (Currently Amended) An image reading apparatus according to
Claim 29, ~~characterized in that~~ wherein the bending direction of a reference axis ray on
each off-axial reflecting surface of said imaging optical element is in a cross section
perpendicular to the line direction of said line sensor.

31. (Currently Amended) An image reading apparatus according to
Claim 30, ~~characterized in that~~ wherein the stop in said imaging optical element is disposed
near substantially the center of ~~the~~ an optical path between the light incidence surface and
the light exit surface of the imaging optical element.

32. (Currently Amended) An image reading apparatus according to
Claim 30, ~~characterized in that said~~ wherein the stop differs in an ~~the~~ aperture width
thereof in a cross section perpendicular to the line direction of the sensor line and an ~~the~~
aperture width in a direction parallel to the line direction.

33. (Currently Amended) An image reading apparatus according to Claim 32, ~~characterized in that said~~ wherein the stop is constructed integrally with the off-axial reflecting surfaces proximate thereto.

34. (Currently Amended) An image reading apparatus according to any one of Claims 4, 5, 7 to 23, or 25 to 33, ~~characterized in that~~ wherein said image information is a color image.

Add new claims 35-45 as follows.

35. (New) An image reading apparatus comprising:
an original supporting table on which an original is placed;
an imaging optical element for imaging image information on the surface of the original on a line sensor; and
a line sensor for reading the image information,
wherein said imaging optical element has a plurality of off-axial reflecting surfaces differing in the direction of incidence and the direction of emergence of a reference axis ray from one another and having curvatures,
wherein the bending direction of the reference axis ray on each off-axial reflecting surface of said imaging optical element is in a cross section perpendicular to the line direction of said line sensor, and

wherein the direction of the reference axis ray emerging from said imaging optical element is substantially orthogonal to the direction of the reference axis ray incident on said imaging optical element.

36. (New) An image reading apparatus comprising:
an original supporting table on which an original is placed;
an imaging optical element for imaging image information on the surface of the original on a line sensor; and

a line sensor for reading the image information,
wherein said imaging optical element has a plurality of off-axial reflecting surfaces differing in the direction of incidence and the direction of emergence of a reference axis ray from one another and having curvatures,

wherein the bending direction of the reference axis ray on each off-axial reflecting surface of said imaging optical element is in a cross section perpendicular to the line direction of said line sensor, and

wherein the direction of the reference axis ray emerging from said imaging optical element is substantially the same direction as the direction of the reference axis ray incident on said imaging optical element.

37. (New) An image reading apparatus comprising:
an original supporting table on which an original is placed;

an imaging optical element for imaging image information on the surface of the original on a line sensor; and

a line sensor for reading the image information,

wherein said imaging optical element has a plurality of off-axial reflecting surfaces differing in the direction of incidence and the direction of emergence of a reference axis ray from one another and having curvatures,

wherein the bending direction of the reference axis ray on each off-axial reflecting surface of said imaging optical element is in a cross section perpendicular to the line direction of said line sensor, and

wherein the direction of the reference axis ray incident on said imaging optical element and the direction of the reference axis ray emerging from said imaging optical element are substantially opposite directions.

38. (New) An image reading apparatus comprising:

an original supporting table on which an original is placed;

an imaging optical element for imaging image information on the surface of the original on a line sensor; and

a line sensor for reading the image information,

wherein said imaging optical element has a plurality of off-axial reflecting surfaces differing in the direction of incidence and the direction of emergence of a reference axis ray from one another and having curvatures, and

wherein said imaging optical element has a stop near substantially the center of the optical path between a light incidence surface and a light exit surface thereof.

39. (New) An image reading apparatus according to Claim 38, wherein the stop is formed by an effective surface of an off-axial reflecting surface located near substantially the center of the optical path between the light incidence surface and the light exit surface of said imaging optical element.

40. (New) An image reading apparatus comprising:
an original supporting table on which an original is placed;
an imaging optical element for imaging image information on the surface of the original on a line sensor; and

a line sensor for reading the image information,
wherein said imaging optical element has a plurality of off-axial reflecting surfaces differing in the direction of incidence and the direction of emergence of a reference axis ray from one another and having curvatures,

wherein the bending direction of the reference axis ray on each off-axial reflecting surface of said imaging optical element is in a cross section perpendicular to the line direction of said line sensor, and

wherein said imaging optical element is comprised of six off-axial reflecting surfaces, and when an off-axial reflecting surface for counter-clockwisely deflecting the reference axis ray is defined as a plus deflecting surface, and an off-axial reflecting surface

for clockwisely deflecting the reference axis ray is defined as a minus deflecting surface, said imaging optical element has the same number of plus deflecting surfaces and minus deflecting surfaces, and the off-axial reflecting surface most adjacent to the exit side is disposed on the original side on the incidence reference axis relative to the off-axial reflecting surface most adjacent to the incidence side.

41. (New) An image reading apparatus according to Claim 40, wherein the plus deflecting surfaces and the minus deflecting surfaces are disposed so as to be opposite deflecting surfaces relative to a stop.

42. (New) An image reading apparatus according to Claim 40, wherein an off-axial reflecting surface of said imaging optical element which is most adjacent to the incidence side is designed to have a converging action

43. (New) An image reading apparatus according to Claim 40, wherein at least one off-axial reflecting surface of said imaging optical element cuts infrared light.

44. (New) An image reading apparatus according to Claim 40, wherein said imaging optical element is disposed in a housing along the surface of the original in parallel to a reflecting mirror.

45. (New) An image reading apparatus according to any one of Claims 35 to 44, wherein said image information is a color image.